COMPUTER BASED MORBIDITY SCREENING FOR INTENSIVE CARE

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Abstract

Described in this paper is the State Transition Screen (STS) and its application to computer-based morbidity screening of patients in intensive care. In STS one compares daily ICU condition with hospital admission condition and screens patients with substantial changes. It relies on the Global Index which summarizes the condition of a critically ill or injured patient using the statistically most powerful measurements among respiratory, renal, hepatic and central nervous system variables.

A major goal of emergency medical research is to develop accurate methods to evaluate the care of critically ill and injured patients. Recently the authors have developed a three-phase approach that provides qualitative and quantitative assessments of patient severity and of outcome in terms of both mortality and morbidity.\cite{1-8} For trauma patients each phase utilizes both anatomical and physiological measures to assess severity of injury and can be used to evaluate pre-hospital, in-hospital and system care.

The first phase -- preliminary (PRE) -- identifies unexpected deaths and survivors. It is semiquantitative and intended for self-audit. The second phase -- state transition screen (STS) -- serves as a morbidity screen, identifying patients with unusual clinical state transitions. Such patients are those who improve substantially for a time before they die and those who deteriorate substantially for a time before they recover. The third phase -- definitive (DEF) -- is a quantitative and statistically rigorous assessment that accounts for patient mix, the reliability of the severity indices, and statistical significance. Both STS and DEF can also be used to assess specific therapeutic modalities.

In the paper we restrict our discussion to State Transition Screen and its application to morbidity screening of patients in intensive care.

The concept of STS is simple: one compares daily ICU condition with hospital admission condition and screens patients with substantial changes. It is based on the concepts of Global Index, Morbidity Transition (MT) and Minimum Morbidity. The Global Index summarizes the condition of a critically ill or injured patient in a single number that is based on the statistically most powerful measurements among respiratory, renal, hepatic, and central nervous system variables.\cite{3-9}

The factors included in the Global Index are the Respiratory Index, serum creatinine, serum bilirubin, and the Glasgow Coma Scale. The lower the score the higher the probability of survival. It is computed as follows:

$$\text{Global Index} = R_n + C_n + B_n + G_n$$

where

- $R_n = 1.5 \times \text{Respiratory Index}$
- $C_n = 0$ if Serum Creatinine is one or less
- $B_n = 0.5 \times \text{Serum Bilirubin}$
- $G_n = 15 - \text{Glasgow Coma Scale}$

The Respiratory Index is defined as follows:

$$\text{RI} = \frac{F_{102} - P_a\text{CO}_2 - P_a\text{O}_2}{F_{102}}$$

where

- $F_{102} = \text{fractional concentration of } O_2 \text{ in inspired gas}$
- $P_a\text{O}_2 = \text{arterial partial pressure of oxygen (mm Hg)}$
- $P_a\text{CO}_2 = \text{arterial partial pressure of carbon dioxide (mm Hg)}$

Morbidity Transition (MT) is defined as follows:

$$\text{MT} = P_L - P_A \text{ (if } P_A > P_L)$$

$$1 - P_A \text{ (if } P_L = P_A)$$

where $P_L$ is the least probability of survival attained during a patient's stay in the intensive care unit, and $P_A$ is the probability of survival based on hospital admission state. This measure can be obtained for survivors and
nonsurvivors. If we conceive of death as the "ultimate" morbidity, then for nonsurvivors \( P_L = 0 \) and \( MT = -P_A \). For survivors whose least probability of survival occurs at admission, then \( P_L = P_A \) and \( MT = 1 - P_A \).

MT ranges from -1.00 to +1.00. A positive MT value indicates that a patient's condition is never any worse than at admission; a negative MT value means that a patient's condition at some time during the hospital stay was poorer than at admission. Survivors with substantial negative MT values are candidates for audit. These are patients for whom the probability of survival at admission is greater than 0.50, but whose probability of survival drops by at least 0.25 during their stay. These patients survive but develop a significant morbidity in terms of vital organ dysfunction. Nonsurvivors selected for audit by STS are those having \( P_A < 0.50 \) and a Least Global Score of 10 or less.

In a series of 605 patients treated at the Washington Hospital Center, 95 percent of the survivors had positive Morbidity Transition values, indicating that their least chance of survival was at admission to the hospital. Twenty-seven survivors got worse during their hospital stay. Most (22 patients) exhibited mild changes (\(< 0.14\)), but 5 had a change in probability of survival of 0.25 or more and thus were identified for audit. In addition, 3 nonsurvivors who experienced apparently substantial changes over that at admission before death were cited for audit by STS, since \( P_A < 0.50 \) and \( MT \leq 10 \).

The three phases PRE, STS, and DEF have been implemented on an IBM Personal Computer. In the computer implementation of STS the Global Index is coupled with anatoglyphs for tracking patient state. The word glyph signifies a pictorial symbol. In the anatoglyph outlines of several vital organs are represented on a human silhouette at the proper anatomical sites. Each organ outline is colored into various levels indicating degrees of derangement. A series of daily anatoglyphs transform a patient's charts into a picture sequence that can be read at a glance.

Color computer frames of all of the concepts will be presented.

References